Fraser River Salmon

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Background

The Fraser River (Figure 1) is Canada's largest salmon producer, supporting five species of Pacific salmon.[1] The most valuable species harvested is the sockeye salmon (*Oncorhynchus nerka*), which is the second most abundant species. The Fraser River has been compared to Alaska's largest salmon producer, Bristol Bay.[2] So, how do the two systems really match up?

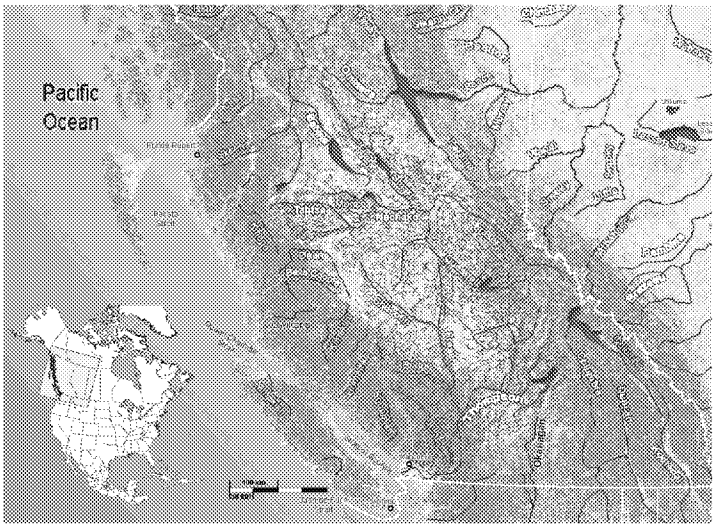

Figure 1. The Fraser River (watershed outline in green) is approximately 1,375 km long (854 mi) with a drainage basin of 220,000 km^2 (84,942 mi^2), about the size of the state of Utah.

Sockeye Populations

Fraser River runs averaged about eight million sockeye until the early 1990s, when they began to decline (Figure 2). In the last 6 of 11 years, the Fraser River sockeye fishery **closed** due to poor returns,[3] and biological productivity is now at an **all-time low**, indicating populations are barely replacing themselves.[4] From 2007 through 2009, total runs failed to exceed two million fish, prompting a $15 million federal judicial inquiry into declines.[5] In 2010, an anomalous 30 million salmon returned to the Fraser. While scientists remain unsure, Fraser River experts concluded one factor in the high return was likely **closures of fisheries** in 2006 which produced most of the 2010 sockeye run.[6] That closure allowed higher than average escapement, producing higher rates of return not seen since the 1970s.[7] In contrast, total sockeye runs to Bristol Bay averaged **29 million** since 1956, **quadrupling** that of the Fraser (Figure 2).[8]

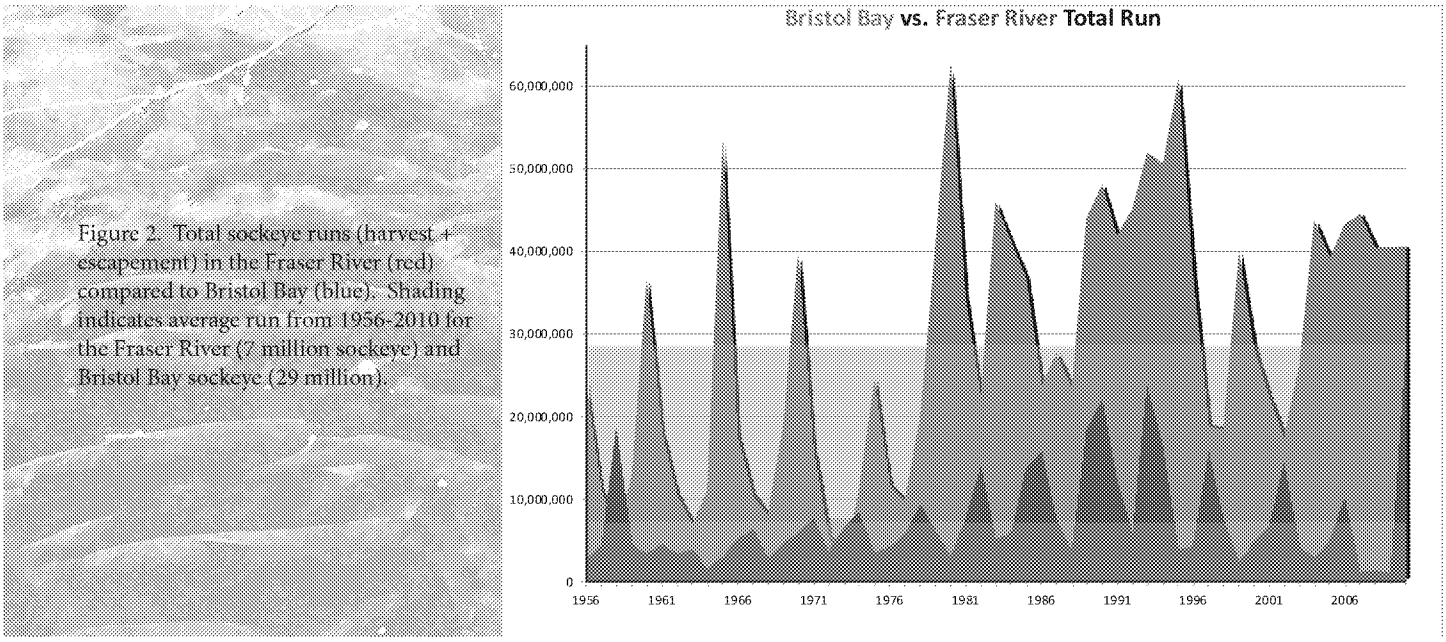

Figure 2. Total sockeye runs (harvest + escapement) in the Fraser River (red) compared to Bristol Bay (blue). Shading indicates average run from 1956-2010 for the Fraser River (7 million sockeye) and Bristol Bay sockeye (29 million).

[1] Groot, C. and L. Margolis. 1991. Pacific Salmon Life Histories. UBC Press, Vancouver BC.
[2] http://juneauempire.com/stories/030411/sta_794320283.shtml. Accessed 10 May 2011.
[3] http://www.davidsuzuki.org/media/news/downloads/2010/Fraser-sockeye-backgrounder.pdf. Accessed 14 February 2011.
[4] Pacific Salmon Commission, 2011.
[5] http://www.cohencommission.ca/en/StatusReports.php. Accessed 8 February 2011.
[6] Ibid.
[7] Fraser Sockeye 2010. Findings of a scientist's think tank. http://www.sfu.ca/cs/science/resources/1291745499.pdf Accessed 15 February 2011.
[8] Data from Pacific Salmon Commission and Alaska Department of Fish and Game

Conservation Status

Five of eleven Fraser River sockeye salmon stocks evaluated by the International Union for the Conservation of Nature (IUCN) are considered threatened,[9] including one categorized as **Critically Endangered**, three categorized as **Endangered**, and one categorized as **Vulnerable** (Figure 3). The Cultus Lake sockeye salmon population in the lower Fraser is also designated as endangered by the Canadian government Committee on the Status of Endangered Wildlife in Canada[10] (CoSEWIC). In contrast, Bristol Bay has no threatened or endangered stocks and only the Kvichak River drainage is considered a stock of concern, and sockeye runs there have recently improved.[11] Indeed, **Bristol Bay is considered one of North America's last salmon strongholds supporting historic numbers of sockeye and other salmon species**.[12]

Factors in Fraser Declines

While factors in Fraser River salmon declines are not fully understood, several are currently being explored for the federal judicial inquiry including: **environmental changes of freshwater and inland habitat, marine habitat, aquaculture, predators, diseases**, and **water temperatures**.[13]

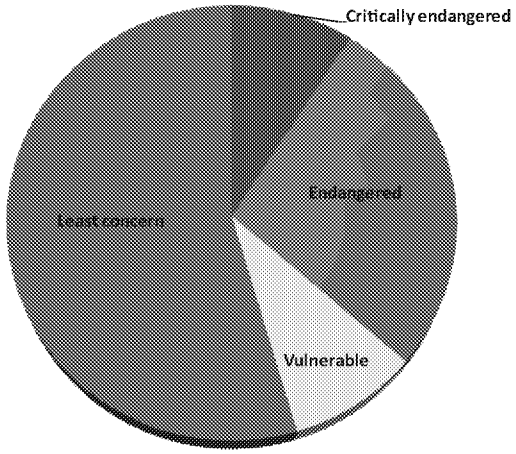

Figure 3. Fraser River sockeye salmon IUCN Red List status. From Rand *et al.* 2008.

Related factors include:

Water Quality: The Fraser River is the most heavily **urbanized and industrialized** water body in British Columbia.[14] Activities including mining, pulp mills, agriculture, forestry, transportation and other urbanization cause **exceedances** in water quality guidelines for: dissolved oxygen, temperature, copper, zinc, lead, cadmium, chromium, and nutrients which can harm aquatic life.[15] In contrast, available data for waters in the Bristol Bay region indicate cold, well-oxygenated conditions with low concentrations of dissolved metals and other solutes.[16] Bristol Bay is not highly urbanized or industrialized.

Climate Change: Warmer than average water temperatures have caused up to **80% pre-spawning mortality** of some sockeye populations in the Fraser River,[17] a problem which may increase as rivers continue to warm.[18] Additionally, warmer water temperatures are tied to increased incidence of a **viral infection**[19] which may contribute to run time changes and pre-spawn mortality. Unusually warm temperatures can also **alter food webs**, changing predator-prey balances.[20] Higher temperatures also result in **lower oxygen levels** in the water, which stress fish.[21]

Other factors: Although controversial, a recent study suggests salmon farms in the marine environment near the mouth of the Fraser River cause increases in transmission of sea lice to salmon smolts which may impact their survival. [22]

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[9] Rand, P.S. 2008. *Oncorhynchus nerka* (Fraser River, South Thompson). In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <http://www.iucnredlist.org>. Downloaded on 03 February 2011.

[10] http://www.dfo-mpo.gc.ca/species-especes/species-especes/cultus_sockeyesalmon-saumonsockeye-eng.htm. Accessed 10 May 2011.

[11] Morstad, S. and T.T. Baker. Kvichak River sockeye salmon stock status and action plan, 2009: a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game Special Publication No. 09-16. 24 pp.

[12] Luck, M., N. Maumenee, D. Whited, J. Lucothe, S. Chilcote, M. Loragn, D. Goodman, K. McDonald, J. Kimball, and J. Stanford. 2010. Remote sensing analysis of physical complexity of North Pacific Rim rivers to assist wild salmon conservation. Earth Surface Processes and Landforms 35: 1330-1343. Quammen, D. Where the salmon rule. National Geographic August 2009, p. 41.

[13] http://www.cohencommission.ca/en/ Accessed 15 May 2011.

[14] Ministry of Environment, Government of British Columbia. 1985. Ambient water quality assessment and objectives for the Fraser River sub-basin from Kanaka Creek to the mouth. Overview Report. http://www.env.gov.bc.ca/wat/wq/objectives/fraserkanaka/fraserkanaka.html. Accessed 15 February 2011.

[15] Environment Canada. 2007. British Columbia and Yukon Territory water quality report (2001-2004): An application of the Canadian Water Quality Index.

[16] Zamzow, K. 2011. Baseline surface water quality near the proposed Pebble Mine, Alaska, 2009-2010: Nushagak, Kvichak, and Chulitna drainage headwaters. Report for The Nature Conservancy. 298 pp.

[17] Farrell, A.P., S.G. Hinch, S.J. Cooke, D.A. Patterson, G.T. Crossin, M. Lapointe, M.T. Mathes. 2005. Pacific salmon in hot water: Applying aerobic scope models and biotelemetry to predict the success of spawning migrations. Physiological and Biochemical Zoology 81(6): 697-708.

[18] Eliason, E.J., T.D. Clark, M.J. Hague, L.M. Hanson, Z.S. Gallagher, K.M. Jeffries, M.K. Gale, D.A. Patterson, S.G. Hinch, and A.P. Farrell. 2011. Differences in thermal tolerance among sockeye salmon populations. Science 332: 109-112.

[19] Ibid.

[20] Allan, J.D. 1995. Stream Ecology: Structure and function of running waters. Chapman & Hall, Oxford. 388 pp.

[21] Rand, P.S., S.G. Hinch, J. Morrison, M.G.G. Foreman, M.J. MacNutt, J.S. MacDonald, M.C. Healey, A.P. Farrell, and D.A. Higgs. 2006. Effects of river discharge, temperature, and future climates on energetics and mortality of adult migrating Fraser River sockeye salmon. Transactions of the American Fisheries Society 135: 355-667.

[22] Price, M.H.H, S.L. Proboszcz, R.D. Routledge, A.S. Gottesfeld, C. Orr, and J.D. Reynolds. 2011. Sea louse infection of juvenile sockeye salmon in relation to marine salmon farms on Canada's west coast. PLoS One 6(2): 1-9.